SYSTEM AND METHOD OF COINSURANCE WAFER MANAGEMENT

BACKGROUND

The present invention relates to wafer management, and particularly to a system and method of coinsurance wafer management for use in MPW (Multi-Project Wafer) shuttle service that manages process scheduling of the coinsurance wafers and provides a business model that makes good use of the coinsurance wafers.

Development of IC (Integrated Circuit) fabrication technology in the semiconductor industry has lead to exponential growth in mask cost for each process. Taiwan Semiconductor Manufacturing Company (TSMC) has developed a foundry industry device prototyping service called Cyber shuttle or MPW shuttle service enabling designers to explore the benefits of leading-edge technology without committing to large volume wafer starts, and helping clients to shorten their new design development and reduce the development costs, including mask costs, during trial production and characteristic evaluation of the real chip trial stage. In addition, the MPW shuttle service

dramatically reduces NRE (Non-Recurring Engineering) charges for small wafer volumes, enabling fast, low-cost prototyping.

The MPW shuttle service enables different clients to book an MPW shuttle and deliver their product design to the MPW

5   shuttle service provider. Once all of the design information is received, each design is translated and produced on a common mask with appropriate allocation. Subsequent to IC fabrication, the MPW shuttle service provider delivers the ICs to the corresponding clients.

10 Fig. 1 illustrates a schematic diagram of the MPW shuttle service. In Fig. 1, a mask 110 including product designs A (111), B (112) and C (113) is commonly produced for different clients. The mask 110 is transferred to each die 101 of the wafer 100 by photolithography. Subsequent to IC fabrication, the MPW shuttle

15 service provider delivers IC products A (120), B (130) and C (140) to the corresponding clients. The MPW shuttle service enables clients to share costs by producing a common mask for rapid processing of new products and designs to silicon-proven verification status.

In IC fabrication using one mask for one device, a number of insurance wafers are prepared as backup wafers for the original wafers that are scrapped in the process, in which the insurance wafers and the original wafers are processed with the same process. Since this type of the fabrication includes only one device on a wafer, it is clear that the insurance wafers belong to the device owner, and the insurance wafers may be provided to the device owner at no cost if the quantity of the original wafers scrapped in the process is less than that of the insurance wafers.

In another type of IC fabrication using one mask for several devices, such as the MPW shuttle service, a number of backup wafers are prepared as replacements if the original wafers are scrapped in the process. Since the wafers may be produced into different devices using a common mask and these devices belong to different device owners, the backup wafers are called "coinsurance wafers" belonging to all device owners. However, the information of the coinsurance wafers cannot be disclosed in detail or freely disclosed due to confidentiality considerations.

With the advance of IC fabrication, only a few of the coinsurance wafers become replacements due to process failure. However, since device owners cannot receive sufficient information regarding the coinsurance wafers, the MPW shuttle

5   service provider or foundry and the device owners cannot make good use of the coinsurance wafers, resulting in scrapping of the coinsurance wafers and increased production costs. In addition, if the device owners need more wafers, they have to restart a complete wafer fabrication process, thereby

10 increasing the cycle time of fabrication and related costs.

SUMMARY

The present invention is proposed to solve the aforementioned issues. It should be noted that, although this invention will be described from the perspective of an IC

15 foundry, its concept and spirit should not be limited to IC foundries but may be applicable to other factories, service suppliers and products.

Accordingly, it is an object of the present invention to provide a system and method of coinsurance wafer management for

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use in MPW shuttle service that manages process scheduling of the coinsurance wafers.

It is another object of the present invention to provide a system and method of coinsurance wafer management including

5   a new business model that makes good use of the coinsurance wafers.

To achieve the above objects, the present invention provides a system and method of coinsurance wafer management. According to one embodiment of the invention, the system

10   includes at least a production line to process at least a MPW shuttle including a plurality of original wafers and a quantity of coinsurance wafers with a common fabrication process before metal layering, process the original wafers with different metal layering fabrication processes according to the metal layer

15   technology of each device design of the MPW shuttle, and withhold the coinsurance wafers from further fabrication.

The production line further releases at least one of the coinsurance wafers to replace each corresponding original wafer scrapped in the common fabrication process, and processes it

20   with the corresponding metal layering fabrication process.

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The production line further splits the MPW shuttle into a plurality of child lots according to the metal layering technology of each device design of the MPW shuttle when the common fabrication process is complete, in which one child lot

5   comprises the coinsurance wafers, and the other child lots are processed with different metal layering fabrication processes.

The system further includes an order management unit to receive a request for at least one designated device design after the metal layering fabrication processes and before a cutoff

10   date of the MPW shuttle, and the production line releases at least one of the coinsurance wafers, and processes it with the corresponding metal layering fabrication process when the request is received.

The system further includes a transmission unit to transfer

15   information of the coinsurance wafers, and of the original wafers corresponding to the respective device designs to the corresponding clients via a network.

According to another embodiment of the invention, a method of coinsurance wafer management first processes at least a MPW

20   shuttle with a common fabrication process before metal layering,

in which the MPW shuttle includes a plurality of original wafers

and a quantity of coinsurance wafers. Then, the original wafers

are processed with different metal layering fabrication

processes according to a metal layering technology for each

5   device design of the MPW shuttle, and the coinsurance wafers are

withheld without further fabrication.

The method further releases at least one of the coinsurance

wafers to replace each corresponding original wafer scrapped in

the common fabrication process, and processes it with the

10   corresponding metal layering fabrication process.

The method further splits the MPW shuttle into a plurality

of child lots according to the metal layering technology of each

device designs of the MPW shuttle when the common fabrication

process is complete, in which one child lot comprises the

15   coinsurance wafers, and the other child lots are processed with

different metal layering fabrication processes.

The method further receives a request for at least one

designated device design after the metal layering fabrication

processes and before a cutoff date of the MPW shuttle. When the

20   request is received, at least one coinsurance wafer is released,

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and processed with the corresponding metal layering fabrication process.

The method further transfers information of the coinsurance wafers and information of the original wafers

5   corresponding to the respective device designs to the corresponding clients via a network.

The above-mentioned method may take the form of program code embodied in a tangible media. When the program code is loaded into and executed by a machine, the machine becomes an

10   apparatus for practicing the invention.

One feature of the present invention is withholding of the coinsurance wafers processed from common fabrication process before metal layering, such that time for remaining fabrication processes is reduced if the coinsurance wafers are needed as

15   supplements.

Another feature of the present invention is provision of sufficient information to clients to make decisions regarding application of the coinsurance wafers rather than a new wafer start, thereby reducing the cycle time of fabrication and

20   related costs.

A detailed description is given in the following embodiments with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The aforementioned objects, features and advantages of

5   this invention will become apparent by referring to the following detailed description of the preferred embodiment with reference to the accompanying drawings, wherein:

Fig. 1 is a schematic diagram illustrating the MPW shuttle service;

10   Fig. 2 is a schematic diagram illustrating the architecture of the coinsurance wafer management system according to one embodiment of the present invention;

Fig. 3 is a schematic diagram illustrating the production period of a MPW shuttle according to one embodiment of the

15   present invention;

Fig. 4 A and 4B show an example of information of the MPW shuttle;

Fig. 5A and 5B are flowcharts showing the process of the coinsurance wafer management method according to one embodiment of the present invention; and

Fig. 6 is a schematic diagram illustrating a storage medium for storing a computer program providing the coinsurance wafer management method.

DESCRIPTION

The present invention provides a system and method for overcoming conventional coinsurance wafer management problems in the MPW shuttle service.

Fig. 2 illustrates the architecture of the coinsurance wafer management system 200 according to one embodiment of the present invention. The system 200 includes a MPW shuttle service unit 210, a determination unit 220, an order management unit 230, a production line 240, a MES (Manufacturing Execution System) 250, a transmission unit 260, and a delivery unit 270.

The MPW shuttle service unit 210 provides related information of the MPW shuttles, such as reservation status. Clients may use the MPW shuttle service unit 210 to book a

specific MPW shuttle for their device designs, and provide mask

data of their device designs to the system. The determination

unit 220 may determine the quantity of coinsurance wafers

according to a scrapping rate and the quantity of original wafers

5   reserved in a MPW shuttle, in which the "original" wafers

represent wafers needed by the MPW shuttle. The quantity of

original wafers can be calculated according to the requested

quantity, size and allocation of the booked device designs, and

the scrapping rate can be obtained by analyzing the related

10   manufacturing history.

After a common mask is produced according to the prepared

mask data, the production line 240 may start the MPW shuttle and

fabricate wafers. Fig. 3 illustrates the production period of

the MPW shuttle according to one embodiment of the present

15   invention. Complete production of the MPW shuttle has four

periods. In period P1, before metal layering, the production

line 240 processes the MPW shuttle including the original wafers

and the coinsurance wafers with a common fabrication process,

such as poly fabrication. After the common fabrication process

20   finishes, the MPW shuttle is split into a plurality of child lots

according to the metal layering technology, such as the number

of metal layers of each device designs, in which one child lot

includes the coinsurance wafers, and is withheld from the metal

layering fabrication process. In this case, the wafers 300 of

5   the MPW shuttle are split into four child lots 310, 320, 330 and

340, of which child lot 340 includes the coinsurance wafers.

Subsequently, in period P3, respective child lots (310, 320 and

330) are processed with different metal layering fabrication

processes. After metal layering fabrication, in period P4,

10   products (311, 312, 321, 322, 331, 332 and 333) corresponding

to respective device designs are produced, with the delivery

unit   270   delivering   the   products   to   corresponding

clients/device owners.

It is understood that the production line 240 may release

15   the coinsurance wafers to replace original wafers scrapped in

the common fabrication process, and process them with the

corresponding metal layering fabrication process.

In addition, in period P4, the order management unit 230

may receive a request for at least one designated device design

20   before a cutoff date (COD) of the MPW shuttle. Once the request

is received, if there are enough coinsurance wafers to support

the request, the production line 240 may release a requested

quantity of the coinsurance wafers, and process them with the

corresponding metal layering fabrication processes. The cutoff

5   date of the MPW shuttle can be determined by the order management

unit 230 or the MES 250.

The MES 250 may collect related information of the MPW

shuttle from the production line 240 and the order management

unit 230, which may include process status of the original wafers

10   and/or the coinsurance wafers, the consumption status of the

coinsurance wafers, and the cutoff date at which the coinsurance

wafers will be scrapped. Fig. 4 A and 4B show an example of the

information of the MPW shuttle. In table 400, there are 11 device

designs in the MPW shuttle, and the information includes columns

15   for customer code, device name, lot ID, wafer ID, technology,

fab, tape-in date, process, #P#M (layers of poly and metal), user

type, committed date and coinsurance wafer ID of each device

designs.

The transmission unit 260 may automatically and

20   periodically transmit the information to the device owner via

a network, such as the Internet. It is understood that due to confidentiality considerations, the transmission unit 260 transfers the information of the coinsurance wafers and the original wafers to the corresponding device owner only. For

5   example, the client J181 may only receive the information for row 410 of the table 400.

Fig. 5A and 5B show the coinsurance wafer management method according to one embodiment of the present invention.

In step S501, the determination unit 220 determines the

10   quantity of coinsurance wafers according to a scrapping rate and the quantity of the original wafers reserved in the MPW shuttle. In step S502, the production line 240 processes the MPW shuttle including the original wafers and the coinsurance wafers with a common fabrication process before metal layering. At the same

15   time, in step S503, the MES 250 collects related information of the MPW shuttle from the production line 240, and the transmission unit 260 automatically and periodically transmits the information to the device owner via the network. In step S504, it is determined whether the common fabrication process

20   is complete. If not (No in step S504), the flow returns to step

S503. It is understood that the production line 240 may release the coinsurance wafers to replace the original wafers if scrapped in the common fabrication process.

If the common fabrication process has finished (Yes in step S504), in step S505, the MPW shuttle is split into a plurality of child lots according to the metal layering technology of each device design, in which one of the child lots includes the coinsurance wafers, and in step S506, the child lot including the coinsurance wafers is withheld before metal layering without further fabrication.

Afterward, in step S507, the production line 240 processes respective child lots with different metal layering fabrication processes according to corresponding device design. At the same time, in step S508, the MES 250 collects related information of the child lots from the production line 240, and the transmission unit 260 automatically and periodically transmits the information to the device owner via the network. In step S509, it is determined whether the metal layering fabrication processes is complete. If not (No in step S509), the flow returns to step S508. It is understood that if original wafers are

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scrapped in the metal layering fabrication process, the

production line 240 may release the coinsurance wafers and

process them with the metal layering fabrication process

corresponding to the scraped original wafers. If the metal

5   layering fabrication processes have finished (Yes in step S509),

whereby the products corresponding to each device designs are

produced, in step S510, the delivery unit 270 delivers the

products to corresponding device owners.

In step S511, it is determined whether a cutoff date of the

10   MPW shuttle has passed. If not (No in step S511), in step S512,

it is determined whether a request has been received from the

device owners. If not (No in step S512), the flow returns to

step S511. If a request designating one of the device designs

of the MPW shuttle is received and there are enough coinsurance

15   wafers to support the request (Yes in step S512), in step S513,

the production line 240 releases a requested quantity of the

coinsurance wafers, for processing with the corresponding metal

layering fabrication process. Similarly, at the same time, in

step S514, the MES 250 collects related information for the

20   processed coinsurance wafers from the production line 240, and

the transmission unit 260 automatically and periodically transmits the information to the device owner via the network.

In step S515, it is determined whether the metal layering fabrication process is complete. If not (No in step S515), the
5   flow returns to step S514. If the metal layering fabrication process has finished (Yes in step S515), in step S516, the delivery unit 270 delivers the products to the device owner. Further, if the cutoff date of the MPW shuttle passes (Yes in step S511), in step S517, the remaining coinsurance wafers are
10   scrapped. It is understood that a line out of step S516 goes back to step S511, illustrating the description of the process and allowing for multiple requests before the cut off date.

Fig. 6 is a diagram of a storage medium for storing a computer program providing the coinsurance wafer management
15   method according to the present invention. The computer program product comprises a storage medium 610 having computer readable program code embodied in the medium for use in a computer system 600, the computer readable program code comprising at least computer readable program code processing a MPW shuttle
20   including original and coinsurance wafers with a common

fabrication process before metal layering, computer readable program code 612 withholding the coinsurance wafers before metal layering without further fabrication, computer readable program code 613 processing the original wafers with corresponding metal

5   layering fabrication processes, computer readable program code 614 receiving at least a request designating one of device designs of the MPW shuttle, and computer readable program code 615 releasing the coinsurance wafers for processing with the corresponding metal layering fabrication process.

10   As a result, the present invention provides a system and method of coinsurance wafer management in the MPW shuttle service that manages the process scheduling of the coinsurance wafers. The novel mechanism directs the coinsurance wafers to be processed with common fabrication processes, and withholds

15   them before metal layering, such that time for remaining fabrication is reduced if the coinsurance wafers are needed as supplements. In addition, the new business model of the present invention provides sufficient information for the coinsurance wafers to clients and makes good use of the coinsurance wafers,

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thereby reducing the cycle time of another wafer start and related costs.

The method and system of the present invention, or certain aspects or portions thereof, may take the form of program code (i.e., executable instructions) embodied in tangible media, such as floppy diskettes, CD-ROMS, hard drives, or any other machine-readable storage medium, wherein, when the program code is loaded into and executed by a machine, such as a computer, the machine becomes an apparatus for practicing the invention. The method and systems of the present invention may also be embodied in the form of program code transmitted over some transmission medium, such as electrical wiring or cabling, through fiber optics, or via any other form of transmission, wherein, when the program code is received and loaded into and executed by a machine, such as a computer, the machine becomes an apparatus for practicing the invention. When implemented on a general-purpose processor, the program code combines with the processor to provide a unique apparatus that operates analogously to application specific logic circuits.

Although the present invention has been described in its preferred embodiments, it is not intended to limit the invention to the precise embodiments disclosed herein. Those skilled in this technology can still make various alterations and modifications without departing from the scope and spirit of this invention. Therefore, the scope of the present invention shall be defined and protected by the following claims and their equivalents.

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